

APPARATUS AND METHOD FOR PRODUCING A WEB OF THERMOPLASTIC FILAMENTS.

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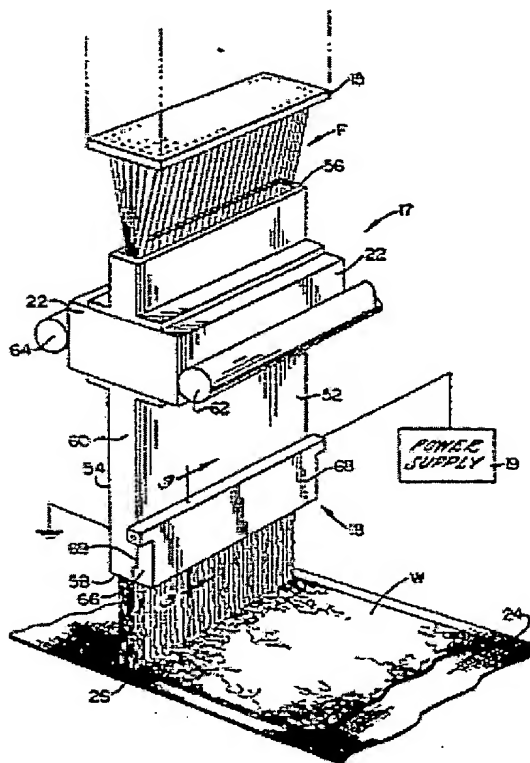
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A slot draw attenuator apparatus and method are provided for producing webs of spunbonded thermoplastic filaments having improved cover even at low basis weights. The filaments are introduced to a slot draw attenuator having corona electrodes mounted in an elongate insulator bar and staggered and spaced along one wall of the attenuator slot near the exit end thereof. The corona electrodes are electrically connected to a high voltage source. The opposing wall of the slot is grounded. A corona is created in the attenuator slot so that the filaments are charged as they exit the attenuator. The electrostatic charge induces repelling forces in the filaments so that the filaments spread before they are randomly deposited upon a forming belt.



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(54) **APPARATUS AND METHOD FOR PRODUCING A WEB OF THERMOPLASTIC FILAMENTS**

**ANLAGE UND VERFAHREN ZUR HERSTELLUNG VON VLIESTOFF AUS
THERMOPLASTISCHEN FILAMENTEN**

**APPAREIL ET PROCEDE PERMETTANT DE PRODUIRE UNE NAPPE DE FILAMENTS
THERMOPLASTIQUES**

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Description

Field of the Invention

5 The invention relates to an apparatus and method for producing a web of spunbonded thermoplastic filaments, and more particularly relates to an apparatus and method for producing a spunbonded web of enhanced uniformity and quality.

Background of the Invention

10 The spunbonding process is widely used for producing nonwoven fabrics from thermoplastic filaments. Spunbonded fabrics can be produced by many routes, but the majority of spunbonding processes include the basic steps of extruding continuous filaments of a fiber-forming thermoplastic polymer, quenching the filaments, drawing or attenuating the filaments, usually by a high velocity fluid, and depositing the filaments on a collection surface to form a web.

15 Manufacturers of spunbonded nonwoven fabrics have long sought to improve the manufacturing process to achieve higher productivity and better quality and uniformity of the spunbonded nonwoven fabric. Maintaining the quality and uniformity of the fabric becomes a particular concern at higher production speeds and when producing fabrics of low basis weight. Several characteristics affect the quality and uniformity of spunbonded nonwoven fabrics.

20 Filament separation is the degree of separation of the individual filaments from one another. Good filament separation occurs when the filaments are randomly arranged with limited parallel contact between the filaments. Ideally, no individual filaments should be in parallel contact with another filament, although, in practice, filaments tend to be in parallel contact over considerable distances. Good filament separation is particularly important for light weight fabrics, where good coverage is more difficult to achieve. Ropiness is the extreme state of poor filament separation. Large numbers of filaments in parallel twisted contact result in long strands in the fabric, which can cause holes or very thin areas in the fabric. Spitchiness is a relative large-scale non-uniformity in basis weight. A fabric having spitchiness is generally weak because of the lower tensile strength of the thin areas of the fabric. Also, a spitchy fabric generally has poor cover properties.

25 In the early spunbond processes which used round attenuator tubes to attenuate and draw the filaments, achieving good uniformity and adequate cover presented significant challenges, particularly when manufacturers attempted to produce lighter weight webs or to produce webs at higher speeds or reduced cost. The round attenuator tubes, often called Lurgi tubes, typically use large quantities of high pressure air that provide the attenuation force for the filaments. This results in high utility costs and high noise levels. Increasing the number of filaments in each tube to increase productivity and to reduce the utility expense results in increased problems of poor filament separation, ropiness and webs having poor cover.

30 Many attempts have been made to overcome the above problems of filament separation, ropiness and spitchiness while still preserving the tensile properties of nonwoven webs made from spunbonded thermoplastic filaments. For example, United States Patent Nos. 3,296,678; 3,485,428 and 4,163,305 describe various apparatus and methods for mechanical and pneumatic oscillation of continuous filament bundles to spread the filaments as they are deposited on the collection surface. United States Patent No. 4,334,340 describes using an air foil at the exit of a round attenuator tube to separate continuous filaments prior to their deposit on a forming wire. Forced air follows the leading edge of the air foil and filaments striking the foil are carried by the forced air onto a forming wire, resulting in a spreading of the filament bundle that promotes random deposit of the filaments.

35 Various electrostatic methods have been proposed to promote spreading of the filament bundle by applying an electric charge to the filaments to cause the filaments to repel one another. United States Patent No. 3,338,992 describes triboelectric charging, in which the filaments are charged by rubbing contact with a suitable dielectric material and repelling forces induced in the filament bundle cause the filaments to separate as they exit a forwarding gun and prior to deposit on the forming wire. However, rubbing contact typically is not desirable for more delicate webs, and this method is also subject to lack of reliability when ambient conditions change. The above-noted United States Patent Nos. 3,338,992 and 3,296,678 also describe electrostatically charging the filament bundle with an ion gun or corona discharge device prior to drawing and forwarding the filaments.

40 United States Patent No. 4,208,366 describes a spunbonding process without the use of forced air attenuation, but which includes electrostatic treatment of the filament bundle. The extruded filaments pass through an electrostatic charging zone and are drawn through a nip between elastomer covered draw rolls. The charged filaments are propelled by the draw rolls into an electrostatic field generated between the rolls and the collecting surface, which attracts the filaments to the collecting surface.

45 United States Patent Nos. 3,163,753, 3,341,394, and 4,009,508, and PCT Application No. W09,107,530 relate to the use of corona electrodes for electrostatic treatment of filament bundles attenuated with round attenuator guns. In U.S. Patent No. 3,163,753, the filament bundle is passed adjacent a charged corona electrode while passing over a

grounded bar. In U.S. Patent No. 3,341,394, a corona is applied while the filaments are under tension and before the filaments enter the attenuation tube. In U.S. Patent No. 4,009,508, the filaments are subjected to electrostatic treatment from a corona after they have been discharged from the round attenuator tube and while the filaments impinge upon a target electrode for spreading in the electric field. In PCT Application No. WO 9,107,530, the filaments exit a round attenuator tube and impinge upon the opposed, converging deflector plates of a filament transfer channel where the filaments are mechanically spread. Charging pins optionally are provided at the exit of the channel for electrostatic separation of the already mechanically spread filaments.

Various slot attenuators have been developed to overcome the problems and limitations of the round attenuator. In a slot attenuator, or slot draw process, the multiple tube attenuators are replaced with a single slot-shaped attenuator that covers the full width of the machine. A supply of air is admitted into the slot attenuator below the spinneret face. The air proceeds down the attenuator channel, which narrows in width, creating a venturi effect to accelerate the air flow and cause filament attenuation. The filaments exit the attenuator channel and are collected on the forming wire. The attenuation air, depending on the type of slot draw process used, can be directed into the attenuation slot by a pressurized air supply above the slot, or by a vacuum located below the forming wire. Slot drawing has various advantages over the Lurgi and other tube-shaped attenuator processes. The slot attenuator is self-threading in that the filaments fall out of the spin block directly into the slot attenuator. The high pressure air used by Lurgi devices is not always required, thereby reducing noise and utility costs.

However, despite the advantages of the slot draw process, cover problems can still occur, particularly for lighter weight fabrics. The forced air stream can introduce turbulence at the point where the web is formed on the collection surface, which adversely affects the quality of the web.

Additionally, manufacturers are still attempting to produce webs at higher processing speeds, which compounds the problem. For example, U.S. Patent No. 4,753,698 describes a technique for mechanically oscillating the rank of filaments exiting a slot draw attenuator and applying vacuum through the forming wire to fix the filaments in place. Coanda rolls set up a pendular movement in the filament rank. However, the swinging velocity of the filaments at the reversal points is zero, and, unless special precautions are taken, pile-ups can occur at the reversal points.

In view of the advantages of the slot draw process over prior filament attenuation techniques, it would be desirable to provide a slot-draw process capable of producing spunbonded fabrics having better cover properties. Accordingly, it is an object of the present invention to provide a slot draw process and apparatus for producing a spunbonded nonwoven web having improved cover properties. More particularly, it is an object of the present invention to provide a slot draw process and apparatus capable of producing nonwoven webs having excellent cover characteristics, despite low basis weight or high processing speeds.

Summary of the Invention

In accordance with the invention, a slot draw attenuator is provided with a corona device positioned for electrostatically charging filaments leaving the attenuator so that electrostatic repelling forces are induced in the filaments to more uniformly spread the filaments before they are deposited on a collection surface to form a web.

The slot draw attenuator, more particularly, has opposing side walls and opposing end walls defining an elongate entrance slot for receiving the filaments, an elongate exit slot from which the filaments are expelled, and a slot-shaped passageway extending between the entrance and the exit and through which the filaments travel while being drawn and attenuated. Means is provided cooperating with the attenuator for introducing a flow of air through the slot-shaped passageway and for drawing and attenuating the filaments passing through the slot-shaped passageway. A collection surface is positioned adjacent the exit slot of the attenuator for receiving the filaments that are expelled from the attenuator to form a web. The corona device includes an electrode means that is carried on the walls of the attenuator and is positioned for generating an electrostatically charged field across the slot-shaped passageway through which the filaments travel.

More specifically, the electrode means includes a series of point or wire corona electrodes that are carried by the exit slot on one of the opposing attenuator walls. These corona electrodes are located in a staggered relation to one another at spaced locations across the width of the wall of the attenuator. A ground is connected to the other opposing wall of the attenuator. The high voltage power source is connected to each of the corona electrodes for producing a corona discharge, i.e. an electrical discharge in the air surrounding the corona electrode. The power is supplied through an electrical conductor that is carried by an elongate insulator bar attached to the attenuator wall. Each of the corona electrodes is mounted along the elongate insulator bar and is electrically connected to the electrical conductor through a high voltage resistor.

The present invention also provides a method of producing a web of thermoplastic filaments in which the filaments are directed into and through an elongate slot-shaped passageway while being attenuated and drawn. The filaments are electrostatically charged in the passageway and are then expelled from the passageway while the repelling forces induced in the filaments by the electrostatic charge cause the filaments to repel one another, thus more uniformly

spreading and distributing the filaments. The filaments are then deposited on a collection surface to form a web.

More specifically, the method includes passing the filaments through a corona zone wherein a high voltage is applied to a series of corona electrodes located along one of a pair of opposing walls in the slot-shaped passageway. The electrodes generate a corona in the slot-shaped passageway between the wall carrying the electrodes and extending to the grounded other wall.

The apparatus and method of the invention are capable of producing spunbonded webs of enhanced uniformity and quality as compared to prior practice. Additionally, by practice of this invention, it is possible to produce spunbonded nonwoven fabrics that have acceptable cover and tensile properties at basis weights significantly lower than produced by previous apparatus and methods.

Brief Description of the Drawings

Some of the features and advantages of the invention have been stated, other advantages will become apparent as the description of the invention proceeds, taken in conjunction with the accompanying drawings, in which:

Figure 1 schematically illustrates an apparatus for forming a spunbonded nonwoven web in accordance with the invention;

Figure 2 is perspective view of a portion of the apparatus of Figure 1 showing the slot draw attenuator;

Figure 3 is a transverse section through the slot draw attenuator, taken along line 2-2 of Figure 2 and showing the corona electrode assembly used for electrostatically charging the filaments;

Figure 4 is a longitudinal section through the corona electrode assembly taken along line 4-4 of Figure 3;

Figure 5 is a perspective view of a portion showing a group of pin-shaped point electrodes mounted in a mounting block for insertion into the corona electrode assembly;

Figure 6 is an enlarged fragmentary cross-sectional view of the corona electrode assembly taken from Figure 3 showing the attachment of the electrodes to high voltage resistors; and

Figure 7 is a perspective view similar to Figure 5, showing an alternate form of corona electrode assembly.

Description of the Illustrated Embodiment

In Figure 1, reference 10 generally indicates an apparatus for producing a spunbonded nonwoven web of continuous filaments. The apparatus 10 includes a melt spinning section for producing continuous filaments of a thermoplastic polymer, including a feed hopper 12 for receiving the polymer raw material in granular or pellet form and an extruder 13 for heating the polymer to a molten plastic state. The spunbonding process is applicable to a large variety of polymer resins, copolymers, and mixtures thereof, and the skilled artisan will recognize that the present invention is not restricted to the specific resins that may be used.

The molten polymer is directed from the extruder 13 at a controlled, metered rate to a generally linear die head or spinneret 15 where the molten polymer is extruded as streams from fine die orifices to form continuous filaments F. The filaments are quenched by a supply 16 of cooling air and are directed to a slot draw attenuation device 17 which covers the full width of the spunbonding machine. A supply of air is admitted into the slot attenuator 17 below the spinneret face. The air proceeds down the attenuator channel, which narrows in width in the direction away from the lower end of the attenuation device and are randomly deposited on an endless forming belt 20 to form a web W.

The attenuation air, depending on the type of slot draw process used, can be directed into the attenuation slot by a pressurized air supply above the slot, by a vacuum located below a forming belt, or by the use of eductors integrally formed in the slot. In the embodiment illustrated, the slot draw attenuator 17 includes an eductor 22 which introduces air into the attenuator 17 between the inlet and exit ends thereof.

A corona device, generally indicated by reference 18, is located adjacent the exit end of the attenuator. The corona device generates a corona of ionized air through which the filaments F pass as they travel through the attenuator, which introduces an electrostatic charge on the filaments, causing the filaments to repel one another. The filaments thus separate and spread apart from one another as they exit the attenuator before being deposited randomly on the endless forming belt 20. The corona device is described more fully below with reference to Figures 2 through 7.

Endless forming belt 20 forms a driven loop 20' that has a generally horizontally extending run 24 for supporting web W and for transporting the web from the initial lay-down point 26. Guide rolls 28 located inside loop 20' extend in substantially parallel relationship in the cross direction of the belt 20 for supporting the belt. Belt 20 is preferably of a porous or foraminous construction so that air from attenuator 17 can pass through the belt and so that vacuum can be applied to the web W through the belt to provide enhanced control over the web during formation and transfer.

As shown in Figure 1, as the web W reaches the downstream end of the belt 20, it is transferred from the belt and is advanced through a calender nip 32 formed between cooperating rolls 30 and 34. The filaments of the web are

thermally bonded together as they pass through the calender nip. Preferably, the one of the rolls has a smooth surface and cooperating roll is provided with a patterned surface so that thermal bonding takes place at discrete locations or points over the surface of the web.

After passing through nip 32, the now thermally bonded web is directed along the calender roll surface to a windup roll 42. Windup roll 42 may be of any conventional type. In the embodiment shown, support rolls 43 and 44 support and rotate the roll 42 of spunbonded nonwoven fabric.

Also shown in Figure 1 is a vacuum box 48 inside the loop 20' that applies a vacuum through belt 20 for holding and immobilizing the web W with respect to the belt 20. Vacuum box 48 is a conventional sheet metal enclosure having a vacuum source connected thereto through conduit 50. Also the vacuum box 48 may be used to facilitate the attenuation of the filaments, as was explained above, by drawing air through the slot draw attenuator 17.

The slot draw attenuator 17 will now be described in more detail in connection with Figure 2. As shown, the attenuator has opposing walls 52 and 54 that define an entrance slot 56 for receiving the filaments F from spinneret 15 and an exit slot 58 from which the attenuated and drawn filaments are discharged. The opposing walls 52 and 54 also define an elongate slot-shaped passageway 60 (Figure 3) that extends between the entrance 56 and the exit 58 and through which the filaments F travel while being drawn and attenuated. Eductors 22, associated with walls 52 and 54, inject air into the slot shaped passageway 60 and along a downward flow path at a location just below the entrance slot 56. Air is distributed to the eductors through manifolds 62 and 64.

The corona device 18 is located adjacent the exit end 58 of the slot attenuator 17. As shown in Figure 2, it includes a corona electrode assembly 66 that is carried by attenuator wall 52 and extends the full width of wall 52 in the cross direction. The electrode assembly 66 is connected to a high voltage power source 19 and the opposite attenuator wall 54 is grounded.

The electrode assembly 66 includes an elongate bar 68 formed of an electrical insulator with high dielectric strength, such as plastic. Insulator bar 68 is attached to the outer surface of attenuator wall 52. As can be seen more clearly in Figure 3, the bottom edge of attenuator wall 52 terminates a short distance above the bottom edge of the opposing attenuator wall 54 and the insulator bar 68 has a projecting shoulder portion 69 extending from the body of the insulator bar 68 a distance corresponding to the thickness of the wall 52 so that the inner exposed face of the shoulder portion 69 lies coplanar with the inner surface of attenuator wall 52. The projecting shoulder portion 69 of the insulator bar 68 thus forms the bottom portion of the attenuator wall and is located directly opposite the opposing grounded attenuator wall 54. Shoulder portion 69 is shown enlarged in Figure 6. Located in the projecting shoulder portion are cavities 70 in which are mounted a series of spaced apart point electrodes in the form of conductive metal pins 72 with ends which taper to sharpened points projecting into the passageway 60 a short distance. The pins 72 are oriented toward the opposing grounded attenuator wall 54 for creating a corona of ionized air across the entire passageway 60 adjacent the discharge end 58 of the attenuator slot.

Referring now to Figure 4, it will be seen that the pins 72 are arranged in groups extending from a mounting block 74 formed of an electrically insulating material with high dielectric strength. A single mounting block and associated corona electrode pins are shown in enlarged perspective in Figure 5. The mounting blocks are seated on the floor of the cavity 70 and are arranged in two vertically spaced apart rows extending the full width of the insulator bar. The mounting blocks in each row are spaced apart from one another and the mounting blocks in one row are arranged in offset or staggered relation to the mounting blocks in the other row so as to insure that the electrically charged corona field produced by the corona electrodes is uniform and covers the full width of the passageway 60 from left to right as seen in Figure 4.

The respective pins of each mounting block 74 are connected to high voltage power source 19 through a resistor 76. The resistors are located in vertical bores formed in the insulator bar 68. The lower end of each resistor is electrically connected to the respective pins 72 of a mounting block 74 through a central lead and the upper end of the resistor is connected to an electrical conductor or buss 78 which extends the full width of the insulator bar 68 to distribute a high voltage from power source 19.

Any high voltage DC source 19 may be used to establish the electrostatic field between the corona electrodes and grounded opposing slot wall 54. The source should preferably have variable voltage settings up to at least about 50 kV and, preferably, (-) and (+) polarity settings to permit adjustments in establishing the electrostatic field.

When the filaments pass through the corona, they become electrostatically charged, which causes the filaments to repel one another and to separate and to spread apart as they enter the free fall zone located between the attenuator 17 and the forming belt 20 and continue to do so until deposited on the forming belt. The free fall zone should be of sufficient length to provide for the desired filament separation in the web.

Figure 7 shows an alternative form of the corona electrode wherein the electrodes are in the form of a wire rather than individual pins. Thus, as shown in Figure 7, the mounting block 74' has a corona electrode in the form of a wire 72' extending the length of the mounting block.

Example

This example compares the physical properties of spunbonded webs of various basis weights produced in accordance with the present invention using a corona device with webs of comparable basis weight produced by similar processing conditions but without the corona device.

The results tabulated below were achieved under the following process conditions. A polypropylene polymer was melt extruded and drawn by a slot draw attenuator at a filament speed of approximately 1000 to 3000 meters per minute. The distance between the corona device and the forming wire was 350 - 600 mm. The distance between the tip of the pins and the opposite grounded conductive plate was 11 mm and a voltage of from 8 to 30 kV was applied from a high voltage source to the pins. Additionally, a vacuum was applied to the forming wire of from 8 to 180 mm of water and the forming wire traveled at approximately 50 to 200 meters per minute. Samples 1, 3 and 5 were produced with the corona device operating and are thus in accordance with the invention. Samples 2, 4 and 6 are control samples produced on the same apparatus under similar processing conditions, but with the corona device inoperative. Results achieved under these conditions are tabulated below.

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TABLE OF PHYSICAL PROPERTIES

SAMPLE NUMBER	1	2	3	4	5	6
DESCRIPTION	13.56 GSM CORONA	13.56 GSM NON-CORONA	18.64 GSM CORONA	18.64 GSM NON-CORONA	22 GSM CORONA	22 GSM NON-CORONA
BASIS WEIGHT						
-- gm	14.42	13.85	20.45	17.54	21.91	23.36
-- oz/y	0.43	0.41	0.60	0.52	0.65	0.69
CALIPER (mils) microns	(6.2 (0.7)) 158	(6.3 (0.8)) 160	(8.2 (0.5)) 208	(8.0 (1.1)) 203	(8.4 (0.8)) 213	(9.6 (0.7)) 244
DECTEX (dtext)	1.78 (0.38)	1.80 (0.22)	1.95 (0.31)	1.90 (0.27)	1.99 (0.35)	1.81 (0.42)
DENIER (dpf)	1.60 (0.34)	1.62 (0.20)	1.75 (0.28)	1.71 (0.24)	1.79 (0.31)	1.63 (0.38)
TENSILES (g/in)*						
-- CD Newtons/in.	(560 (94)) 5.49	(377 (133)) 3.70	(719 (156)) 7.05	(795 (302)) 7.80	(904 (387)) 8.86	(1082 (252)) 10.61
-- MD	(1587 (157)) 15.56	(819 (226)) 8.03	(2003 (349)) 19.64	(1311 (247)) 12.86	(2923 (595)) 28.66	(1458 (321)) 14.30
MD/CD RATIO	2.83:1	2.17:1	2.79:1	1.65:1	3.23:1	1.35:1
PEAK ELONG. (%)						
-- CD	44 (13)	35 (9)	46 (12)	35 (11)	47 (18)	38 (7)
-- MD	33 (6)	23 (5)	34 (11)	29 (6)	50 (13)	31 (5)
BREAK ELONG. (%)						
-- CD	49 (12)	37 (10)	50 (11)	40 (11)	51 (18)	44 (10)
-- MD	35 (6)	27 (5)	37 (9)	33 (9)	51 (13)	33 (6)
2TEA (in.g./in ²)						
-- CD cm.g/cm ²	(173 (70)) 68.1	(87 (52)) 34	(231 (93)) 91	(206 (119)) 81	(326 (220)) 128	(305 (115)) 120
-- MD	(383 (116)) 151	(144 (60)) 57	(510 (215)) 201	(297 (136)) 117	(1062 (450)) 418	(314 (102)) 124
TRAPEZOID TEAR (lbs)						
--CD Newtons	(1.99 (0.71)) 8.85	(2.39 (0.92)) 10.63	(3.59 (0.98)) 15.97	(3.21 (1.03)) 14.28	(3.98 (0.62)) 17.70	(3.82 (0.89)) 16.99
--MD	(4.20 (1.20)) 18.68	(2.74 (0.98)) 12.19	(4.51 (0.84)) 20.06	(5.17 (1.62)) 23.00	(4.89 (2.37)) 21.75	(4.89 (2.37)) 21.75
% BREAKTHROUGH	8.0 (1.6)	12.3 (2.3)	2.2 (0.7)	5.5 (2.1)	1.6 (0.2)	3.2 (1.2)
FORMATION	3.58 (0.68)	1.18 (0.93)	4.35 (0.49)	1.96 (0.76)	4.51 (0.64)	2.75 (0.76)

() = Standard Deviation
 * 5" gauge length and 5"/min. crosshead speed.

As can be seen from the comparative examples, the fabrics produced by practice of the present invention have

drastically improved physical properties as compared to the control sample of comparable basis weight. The tensile strength, both in the machine direction and in the cross direction, is significantly increased. Additionally, the percentage breakthrough is greatly reduced. The percentage breakthrough is a measurement of the level of penetration of certain size particles during a given time. The lower the percentage breakthrough, the better the quality and cover properties of the web. As also seen from the table, the degree of formation greatly improves with electrostatic application. Formation is the visual appearance of the web, indicating how uniformly the filaments are distributed throughout the entire web. This evaluation also takes into consideration such defects as streaks, splotches, light spots or even holes, and the presence of ropiness. Formation is evaluated by trained individuals visually on a scale of 0 to 5, with 5 being the best.

It should be understood that the specific embodiments described in detail hereinabove and illustrated in the drawings are specific examples of how the present invention may be practiced and that the invention is not limited to these specific embodiments. Those modifications that come within the meaning and range of equivalence of the claims are to be included within the scope of the invention.

15 Claims

1. An apparatus for producing a web of thermoplastic filaments comprising:
 - a) a slot draw attenuator having opposing side walls and opposing end walls defining an elongate entrance slot for receiving filaments, an elongate exit slot from which the filaments are expelled, and a slot-shaped passageway extending between said entrance and said exit and through which the filaments travel while being drawn and attenuated;
 - b) means cooperating with said attenuator for introducing a flow of air through the slot-shaped passageway and for drawing and attenuating the filaments through the slot-shaped passageway;
 - c) a collection surface positioned adjacent said exit slot of said attenuator for receiving the filaments that are expelled from said attenuator to form a filamentary web; and
 - d) corona means positioned for electrostatically charging the filaments that are expelled from said attenuator so that repelling forces are induced in the filaments to more uniformly spread the filaments before they are deposited on said collection surface to form a web.
2. The apparatus according to Claim 1 wherein said corona means includes electrode means carried on said walls of said attenuator and positioned for generating an electrostatic field through which the filaments pass as they travel through said slot-shaped passageway of said attenuator.
3. The apparatus according to Claim 2 wherein said electrode means includes a series of corona electrodes carried by one of said opposing attenuator walls, said corona electrodes being located at spaced locations along the length of the slot-shaped passageway, a ground connected to the other of said opposing attenuator walls, and a high voltage power source connected to each of said corona electrodes.
4. The apparatus according to Claim 3 wherein said electrode means includes an elongate insulator bar carried by said one attenuator wall adjacent said exit slot, and an electrically conductive buss carried by said insulator bar, and wherein said corona electrodes are mounted at spaced locations along said elongate insulator bar and are electrically connected to said conductive buss.
5. The apparatus according to Claim 4 wherein said corona electrodes each comprise a pin having a sharpened point facing into the slot-shaped passageway and a high voltage resistor electrically connecting the pin to said buss.
6. The apparatus according to Claim 4 wherein said corona electrodes each comprise a wire facing into the slot-shaped passageway and a high voltage resistor electrically connecting the wire to said buss.
7. The apparatus according to Claim 3 wherein said corona electrodes are located in staggered relation to one another at spaced locations across the width of said one wall.
8. The apparatus according to Claim 1 further comprising means for extruding filaments of a thermoplastic polymer.
9. The apparatus according to Claim 8 wherein said filament extruding means comprises a spinning beam.
10. The apparatus according to Claim 1 further comprising means for bonding the filaments together after they have

been formed into a web on said belt.

11. The apparatus according to Claim 10 wherein said filament bonding means comprises a calendar nip for bonding the filaments together after they have been formed in to a web on said belt, said apparatus further comprising a windup roll for winding the spunbonded web after passage through said calendar nip.
12. The apparatus according to Claim 1 wherein said filament drawing and attenuating means comprises an adductor for inducing a flow of air through said slot-shaped passageway for drawing and attenuating the filaments.
13. A method for producing a web of thermoplastic filaments comprising directing a plurality of filaments into and through an elongate slot-shaped passageway while attenuating and drawing the filaments as they travel through the passageway, electrostatically charging the filaments as they travel through the slot-shaped passageway, expelling the electrostatically charged filaments from the elongate slot-shaped passageway while permitting the repelling forces induced in the filaments by the electrostatic charge to more uniformly spread the filaments, and depositing the thus spread filaments on a collection surface to form a web.
14. The method according to Claim 13 wherein the step of electrostatically charging the filaments comprises passing the filaments through an electrostatic field formed by a corona.
15. The method according to Claim 14 wherein the step of passing the filaments through an electrostatic field includes applying a high voltage to an electrode located along one of a pair of opposing walls in the slot-shaped passageway and generating a corona in the slot-shaped passageway between the electrode and the opposing wall of the slot-shaped passageway.
16. The method according to Claim 15 wherein the step of applying a high voltage to an electrode comprises distributing the high voltage among a series of corona electrodes extending into the slot-shaped passageway at spaced locations along one wall of the passageway.
17. The method according to Claim 13 further comprising the steps of advancing the collection surface as the filaments are deposited thereon to form a web and thermally bonding the filaments to form a unitary web.

Patentansprüche

1. Einrichtung zum Herstellen einer Bahn von thermoplastischen Filamenten, umfassend:
 - a) einen Schlitzziehverfeinerer, der gegenüberliegende Seitenwände und gegenüberliegende Endwände hat, die einen langgestreckten Eingangsschlitz zur Aufnahme von Filamenten sowie einen langgestreckten Ausgangsschlitz, aus dem die Filamente ausgestoßen werden, und einen schlitzförmigen Durchgang, der sich zwischen dem Eingang und dem Ausgang erstreckt und durch welchen die Filamente laufen, während sie gezogen und verfeinert werden, begrenzen;
 - b) ein mit dem Verfeinerer zusammenwirkendes Mittel zum Einführen einer Strömung von Luft durch den schlitzförmigen Durchgang und zum Ziehen und Verfeinern der Filamente durch den schlitzförmigen Durchgang;
 - c) eine benachbart dem Ausgangsschlitz des Verfeinerers positionierte Auffangoberfläche zum Aufnehmen der Filamente, die aus dem Verfeinerer ausgestoßen werden, um eine filamentäre Bahn zu bilden; und
 - d) ein Koronamittel, das zum elektrostatischen Laden der Filamente, die aus dem Verfeinerer ausgestoßen werden, positioniert ist, so daß Abstoßungskräfte in den Filamenten induziert werden, um die Filamente gleichförmiger auszubreiten, bevor sie auf der Auffangoberfläche zur Ausbildung einer Bahn abgelagert werden.
2. Einrichtung gemäß Anspruch 1, worin das Koronamittel ein Elektrodenmittel aufweist, das auf bzw. in den Wänden des Verfeinerers gehalten und zum Erzeugen eines elektrostatischen Felds, durch welches die Filamente hindurchgehen, wenn sie durch den schlitzförmigen Durchgang des Verfeinerers laufen, positioniert ist.
3. Einrichtung gemäß Anspruch 2, worin das Elektrodenmittel eine Reihe von Koronaelektroden aufweist, die von einer der gegenüberliegenden Verfeinererwände gehalten sind, wobei die Koronaelektroden an beabstandeten Orten entlang der Länge des schlitzförmigen Durchgangs lokalisiert sind, wobei eine Masse bzw. Erde mit der anderen der gegenüberliegenden Verfeinererwände verbunden ist, und wobei eine Hochspannungsleistungsquel-

le mit jeder der Koronaelektroden verbunden ist.

4. Einrichtung gemäß Anspruch 3, worin das Elektrodenmittel ein langgestrecktes Isolatorquerstück aufweist, das von der einen Verfeinerwand benachbart dem Ausgangsschlitz gehalten ist, und einen elektrisch leitfähigen Bus, der von dem Isolatorquerstück gehalten ist, und worin die Koronaelektroden an beabstandeten Orten entlang dem langgestreckten Isolatorquerstück angebracht und elektrisch mit dem leitfähigen Bus verbunden sind.
5. Einrichtung gemäß Anspruch 4, worin jede der Koronaelektroden einen Stift umfaßt, der eine geschärfte Spitze hat, die in den schlitzförmigen Durchgang gewandt ist, und einen Hochspannungswiderstand, der den Stift elektrisch mit dem Bus verbindet.
6. Einrichtung gemäß Anspruch 4, worin jede der Koronaelektroden einen Draht umfaßt, der in den schlitzförmigen Durchgang gewandt ist, und einen Hochspannungswiderstand, der den Draht elektrisch mit dem Bus verbindet.
7. Einrichtung gemäß Anspruch 3, worin die Koronaelektroden in gestaffelter bzw. versetzter Beziehung zueinander an beabstandeten Orten quer über die Breite der einen Wand lokalisiert sind.
8. Einrichtung gemäß Anspruch 1, weiter umfassend ein Mittel zum Extrudieren von Filamenten aus einem thermoplastischen Polymer.
9. Einrichtung gemäß Anspruch 8, worin das Filamentextrudiermittel einen Spinnbalken umfaßt.
10. Einrichtung gemäß Anspruch 1, weiter umfassend ein Mittel zum Binden der Filamente aneinander, nachdem sie auf dem Band zu einer Bahn ausgebildet worden sind.
11. Einrichtung gemäß Anspruch 10, worin das Filamentbindemittel einen Kalandervalzenspalt zum Binden der Filamente aneinander, nachdem sie auf dem Band zu einer Bahn ausgebildet worden sind, umfaßt, wobei die Einrichtung weiter eine Aufwickelwalze zum Aufwickeln der spinngebundenen bzw. spunbonded Bahn nach dem Durchgang durch den Kalandervalzenspalt umfaßt.
12. Einrichtung gemäß Anspruch 1, worin das Filamentzieh- und verfeinerungsmittel einen Adduktor zum Induzieren einer Luftströmung durch den schlitzförmigen Durchgang für das Ziehen und Verfeinern der Filamente umfaßt.
13. Verfahren zum Herstellen einer Bahn von thermoplastischen Filamenten, umfassend das Leiten bzw. Führen einer Mehrzahl von Filamenten in und durch einen langgestreckten schlitzförmigen Durchgang, während die Filamente, wenn sie durch den Durchgang laufen, verfeinert und gezogen werden, das elektrostatische Laden der Filamente, wenn sie durch den schlitzförmigen Durchgang laufen, das Ausstoßen der elektrostatisch geladenen Filamente aus dem langgestreckten schlitzförmigen Durchgang, während es den Abstoßungskräften, die durch die elektrostatische Ladung in den Filamenten induziert worden sind, ermöglicht wird, die Filamente gleichförmiger auszubreiten, und das Ablagern der demgemäß ausgebreiteten Filamente auf einer Auffangoberfläche zur Ausbildung einer Bahn.
14. Verfahren gemäß Anspruch 13, worin der Schritt des elektrostatischen Ladens der Filamente das Hindurchführen der Filamente durch ein mittels einer Korona gebildetes elektrostatisches Feld umfaßt.
15. Verfahren gemäß Anspruch 14, worin der Schritt des Hindurchführens der Filamente durch ein elektrostatisches Feld das Anlegen einer Hochspannung an eine Elektrode umfaßt, die längs einer von einem Paar von gegenüberliegenden Wänden in dem schlitzförmigen Durchgang lokalisiert ist, und das Erzeugen einer Korona in dem schlitzförmigen Durchgang zwischen der Elektrode und der gegenüberliegenden Wand des schlitzförmigen Durchgangs.
16. Verfahren gemäß Anspruch 15, worin der Schritt des Anlegens einer Hochspannung an eine Elektrode das Verteilen der Hochspannung unter einer Reihe von Koronaelektroden umfaßt, die sich in den schlitzförmigen Durchgang an beabstandeten Orten entlang einer Wand des Durchgangs erstrecken.
17. Verfahren gemäß Anspruch 13, weiter umfassend die Schritte des Vorwärtsbewegens der Auffangoberfläche, wenn die Filamente darauf zur Ausbildung einer Bahn abgelagert werden, und des thermischen Bindens der Filamente zur Ausbildung einer einheitlichen Bahn.

Revendications

1. Appareil pour la production d'une nappe de filaments thermoplastiques, comprenant :

- 5 (a) un dispositif d'amincissement par étirage à fente, comportant des parois latérales opposées et des parois d'extrémité opposées qui définissent une fente d'entrée allongée pour recevoir les filaments, une fente de sortie allongée d'où les filaments sont expulsés, et un passage en forme de fente s'étendant entre ladite entrée et ladite sortie et dans lequel les filaments se déplacent pendant qu'ils sont étirés et amincis ;
 10 (b) un dispositif qui coopère avec ledit dispositif d'amincissement pour introduire un flux d'air dans le passage en forme de fente et pour étirer et amincir les filaments se déplaçant dans le passage en forme de fente ;
 (c) une surface de collecte placée près de la dite fente de sortie dudit dispositif d'amincissement, pour recevoir les filaments qui sont expulsés dudit dispositif d'amincissement, afin de former une nappe filamenteuse ; et
 15 (d) un dispositif d'effluve ou d'effet corona placé de manière à charger électrostatiquement les filaments qui sont expulsés dudit dispositif d'amincissement, de sorte que des forces de répulsion sont induites dans les filaments pour étaler plus uniformément les filaments avant leur dépôt sur ladite surface de collecte pour former une nappe.

2. Appareil suivant la revendication 1, dans lequel ledit dispositif d'effluve comprend un dispositif d'électrode porté par lesdites parois dudit dispositif d'amincissement et disposé de manière à engendrer un champ électrostatique à travers lequel les filaments passent pendant leur déplacement dans ledit passage en forme de fente dudit dispositif d'amincissement.

3. Appareil suivant la revendication 2, dans lequel ledit dispositif d'électrode comprend une série d'électrodes d'effluve portées par une desdites parois opposées du dispositif d'amincissement, lesdites électrodes d'effluve étant placées à des positions espacées sur la longueur du passage en forme de fente, une terre connectée à l'autre desdites parois opposées du dispositif d'amincissement, et une source d'alimentation à haute tension connectée à chacune desdites électrodes d'effluve.

4. Appareil suivant la revendication 3, dans lequel ledit dispositif d'électrode comprend une barre isolante allongée portée par ladite une paroi du dispositif d'amincissement près de ladite fente de sortie, et une barre commune électriquement conductrice portée par ladite barre isolante, et dans lequel lesdites électrodes d'effluve sont montées à des positions espacées le long de la dite barre isolante allongée et elles sont électriquement connectées à ladite barre conductrice commune.

5. Appareil suivant la revendication 4, dans lequel lesdites électrodes d'effluve comprennent chacune une tige à pointe vive pénétrant dans le passage en forme de fente, et une résistance à haute tension connectant électriquement la tige à ladite barre conductrice commune.

6. Appareil suivant la revendication 4, dans lequel lesdites électrodes d'effluve comprennent chacune un fil en regard du passage en forme de fente et pénétrant dans celui-ci, et une résistance à haute tension connectant électriquement le fil à ladite barre conductrice commune.

7. Appareil suivant la revendication 3, dans lequel lesdites électrodes d'effluve sont placées de façon décalée les unes par rapport aux autres, à des positions espacées sur la largeur de ladite une paroi.

8. Appareil suivant la revendication 1, comprenant en outre des moyens d'extrusion de filaments d'un polymère thermoplastique.

9. Appareil suivant la revendication 8, dans lequel lesdits moyens d'extrusion de filaments comprennent une poutre de filage.

10. Appareil suivant la revendication 10, comprenant en outre des moyens de liaison des filaments les uns par rapport aux autres après qu'ils aient été formés en une nappe sur ladite surface de courroie.

11. Appareil suivant la revendication 10, dans lequel lesdits moyens de liaison de filaments comprennent un pincement de calandrage pour lier les filaments les uns aux autres après qu'ils aient été formés en une nappe sur ladite courroie, ledit appareil comprenant en outre un rouleau de reprise pour enrouler la nappe liée au filage ou "spunbonded", après passage à travers ledit pincement de calandrage.

12. Appareil suivant la revendication 1, dans lequel ledit dispositif d'étirage et d'amincissement des filaments comprend un éjecteur pour induire un flux d'air dans ledit passage en forme de fente, afin d'étirer et d'amincir les filaments.
- 5 13. Procédé pour la production d'une nappe de filaments thermoplastiques, comprenant la direction d'une pluralité de filaments dans et à travers un passage allongé en forme de fente tout en amincissant et en étirant les filaments pendant leur déplacement dans le passage, la charge électrostatique des filaments pendant leur déplacement dans le passage en forme de fente, l'expulsion des filaments électrostatiquement chargés hors du passage allongé en forme de fente tout en permettant aux forces de répulsion induites dans les filaments par la charge électrostatique d'étaler plus uniformément les filaments, et le dépôt des filaments ainsi étalés sur une surface de collecte pour former une nappe.
- 10 14. Procédé suivant la revendication 13, dans lequel l'étape de charge électrostatique des filaments comprend le passage des filaments à travers un champ électrostatique engendré par effluve.
- 15 15. Procédé suivant la revendication 14, dans lequel l'étape de passage des filaments à travers un champ électrostatique comprend l'application d'une haute tension à une électrode placée le long d'une de deux parois opposées du passage en forme de fente, et la génération d'un effluve dans le passage en forme de fente, entre l'électrode et la paroi opposée du passage en forme de fente.
- 20 16. Procédé suivant la revendication 15, dans lequel l'étape d'application d'une haute tension à une électrode comprend la distribution de la haute tension à une série d'électrodes d'effluve pénétrant dans le passage en forme de fente à des positions espacées le long d'une paroi du passage.
- 25 17. Procédé suivant la revendication 13, comprenant en outre les étapes d'avance de la surface de collecte au fur et à mesure que les filaments se déposent sur celle-ci pour former une nappe, et de liaison-thermique des filaments pour former une nappe unitaire.

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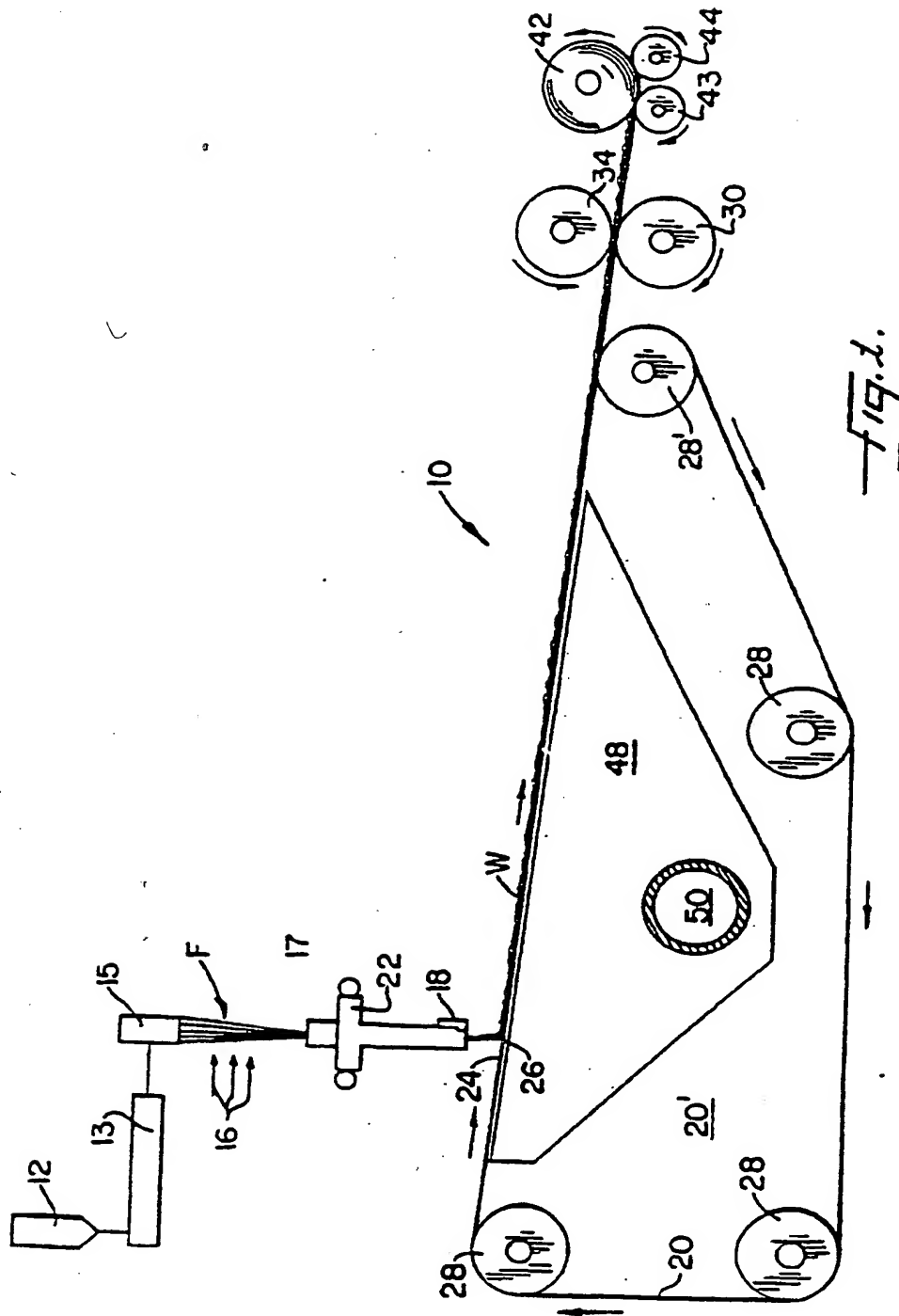
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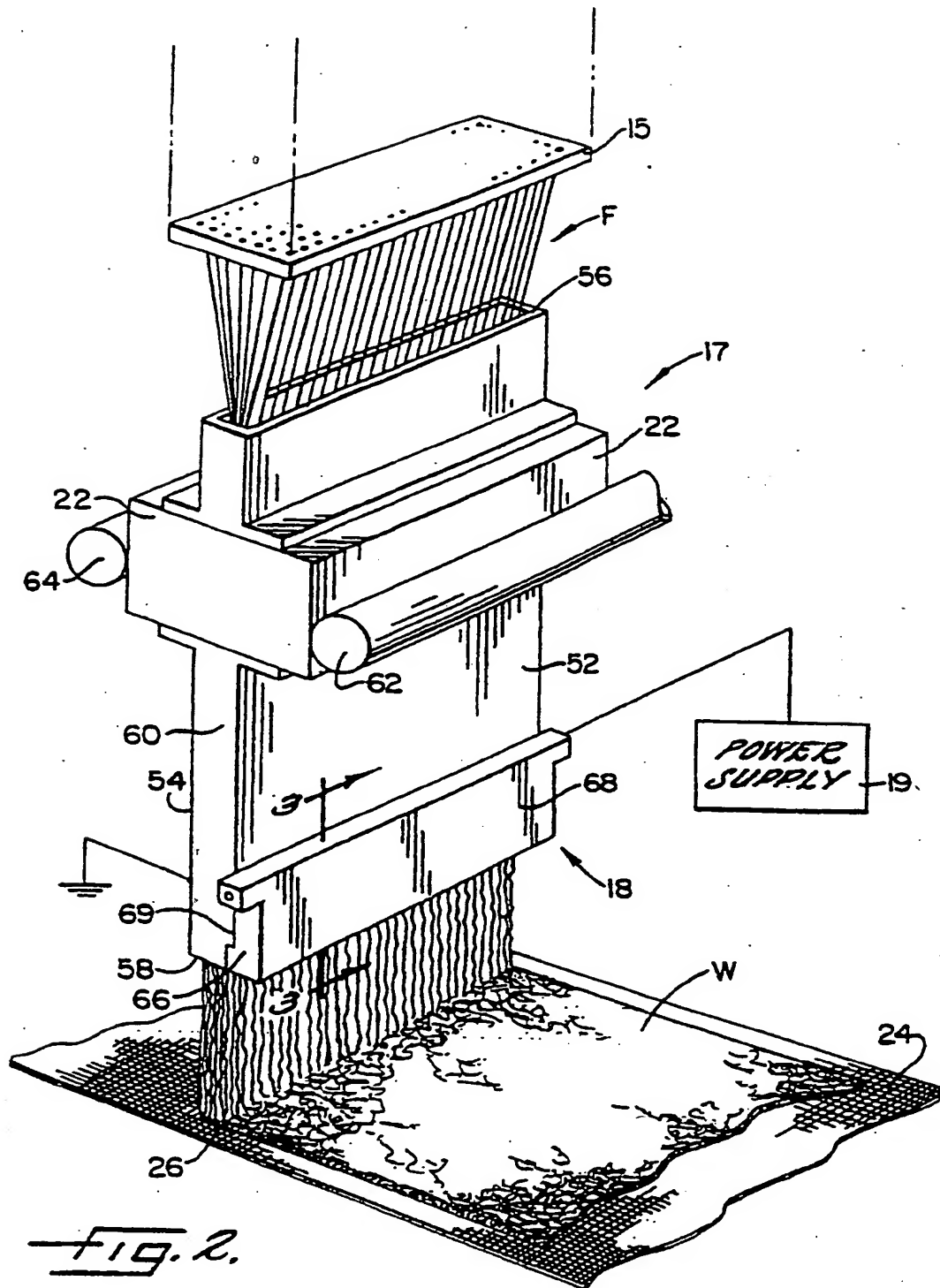
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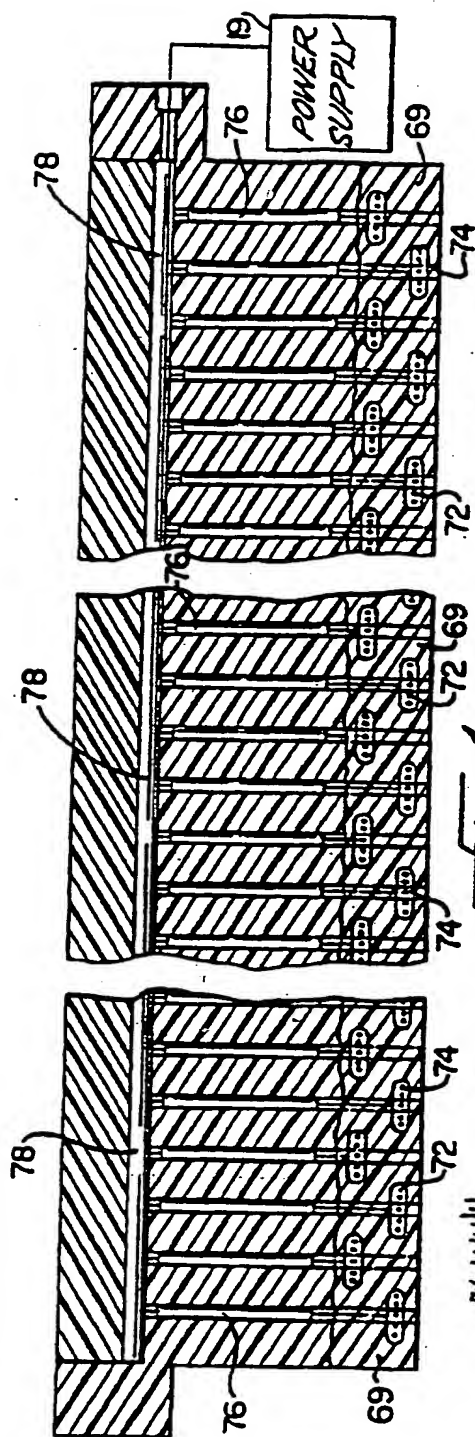


fig. 4.

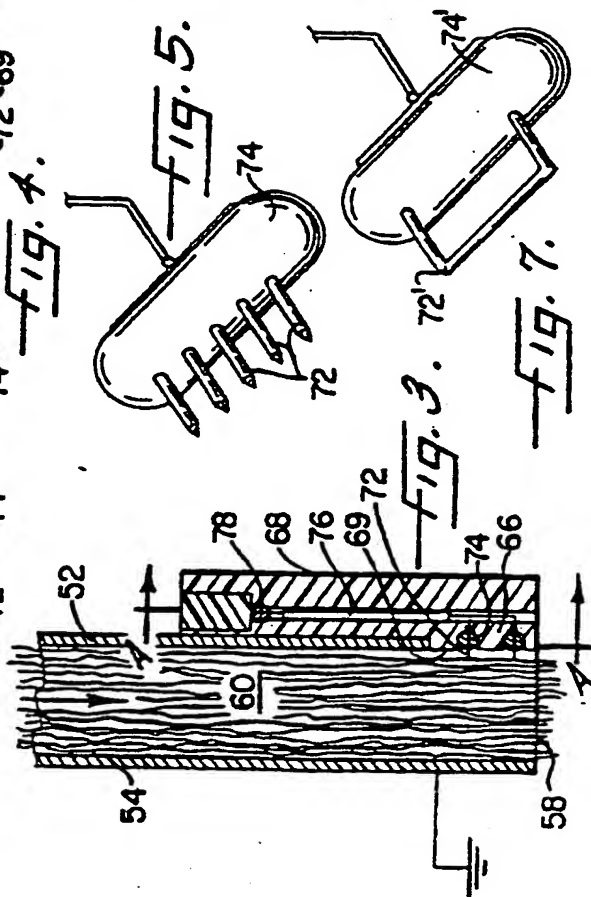


fig. 5.

fig. 3.

fig. 7.

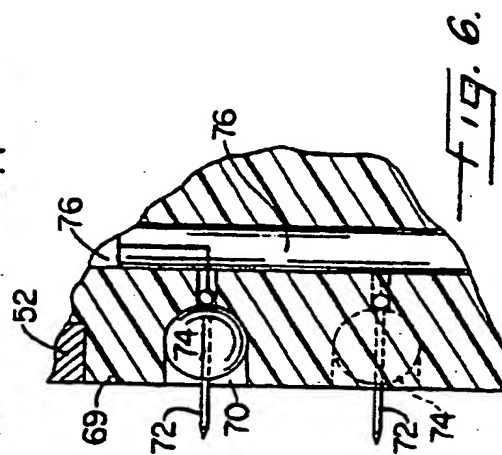


fig. 6.